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PRELIMINARY MANUAL FOR THE SPEECH AUTOINSTRUCTIONAL DEVICE.
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THIS INSTRUCTIONAL MANUAL WAS PREPARED FOR A COMPUTER-BASED SPEECH TRAINING SYSTEM, DESIGNED TO CONDITION FLUENCY IN THE PROSODIC FEATURES OF SPEECH. THE SCOPE OF THE MANUAL COVERED (1) SYSTEM AND SUBSYSTEM SPECIFICATIONS, (2) SYSTEM AND PROGRAM OPERATIONAL CHARACTERISTICS, AND (3) BASIC INFORMATION ON THE CONTROL OF SPEECH PRODUCTION AND PERCEPTION. THE MANUAL IS A PROGRESS REPORT ON AN EXPERIMENTAL RESEARCH PROGRAM IN SPEECH CONTROL. (RELATED REPORTS ARE ED 003 883-ED 003 887.) (JH)

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THE UNIVERSITY OF MICHIGAN

COLLEGE OF LITERATURE, SCIENCE, AND THE ARTS
DEPARTMENT OF PSYCHOLOGY
BEHAVIOR ANALYSIS LABORATORY

Progress Report No. 5
November 1, 1963, to February 1, 1964

Preliminary Manual for the Speech Auto-Instructional Device

Under contract with:

Language Development Section
U. S. Office of Education
Contract No. OE-3-14-013
Washington, D. C.

Administered through:

February 1964

OFFICE OF RESEARCH ADMINISTRATION · ANN ARBOR

THE UNIVERSITY OF MICHIGAN

COLLEGE OF LITERATURE, SCIENCE, AND THE ARTS
Department of Psychology
Behavior Analysis Laboratory

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Progress Report No. 5

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PRELIMINARY MANUAL

for the

SPEECH AUTO-INSTRUCTIONAL DEVICE

A system for conditioning fluency in the prosodic features of speech.

ORA Project 05613

under contract with:

LANGUAGE DEVELOPMENT SECTION
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INSTRUCTION MANUAL

SYSTEM DESCRIPTION See Figures 1 and 2.

The Speech Auto-Instructional Device is a computer-based speech teaching system. It is designed to provide maximum versatility in the conduct of research on conditioning fluency in the prosodic features of speech, in order to provide (1) specifications for an effective and economical device to teach these skills, and (2) basic information on the control of speech production and perception.

The parameters which define the prosodic features of speech are the contours of fundamental frequency which can conveniently be termed (PITCH), speech power (AMPLITUDE), and rhythm (TEMPO).

Analog equipment in the console of the system extracts continuous PITCH and AMPLITUDE information as a function of time from the complex spectrum of speech at the input. A digital computer processes these parameters to extract from each a contour, that is, a selected group of discrete values, which represents the variation of that parameter during the stream of speech. The computer marks and records the time between the selected values of AMPLITUDE; these time values define the TEMPO contour parameter. At this point, each selected discrete value represents an absolute value of PITCH, AMPLITUDE, or TEMPO.

A conversion of units is performed by the computer such that each discrete parameter value is made relative, each to the value immediately preceding and following it, and is therefore independent of where it falls in the absolute range of the parameter. Thus each value has a significance only in its relationship to the values which immediately precede or follow it within its own parameter. The computer stores these relative discrete

values for each parameter, or compares them to values which are already in the computer memory, depending upon the nature of the information being processed.

The two types of information processed are the MODEL, or pattern type, and the SUBJECT, or imitation type. The MODEL information is recorded by an informant on magnetic tape, reproduced by a tape deck in the system console, and presented concurrently to the subject (by means of loudspeakers) and to the computer. The SUBJECT information is produced by the student, seated in front of a microphone in the Student Booth (vide sec. D), while he attempts to imitate the MODEL pattern just presented. The computer stores parameter values of the MODEL, and compares the SUBJECT parameter values to them. The difference between these values is displayed to the experimenter and to the student. This difference is defined as error with respect to the particular parameter set which the system is processing. The error indicates to the student, while he is making the imitation, the magnitude and direction he must modify his imitation in one or more parameters in order to reduce the error signal on the next imitation attempt.

SUBSYSTEM DESCRIPTIONS

A. INPUT CIRCUIT AND AMPLITUDE EXTRACTOR See Figure 3.

The input circuit and amplitude extractor are located physically in the system console. The input circuit serves to channel the speech signals to the loud speakers in the student booth, the voice operated relay, and the parameter extractors, and to provide the proper input level to each circuit. The amplitude extractor generates a negative DC voltage output proportional to the absolute value of the amplitude of the signal input, integrated over 50 msec. A DC amplifier prepares the amplitude signal for input to the computer at a level of 0 to -10 volts.

B. PITCH EXTRACTOR See Figure 4.

The pitch extractor is located physically on the panel of the console. The audio output from the input circuit is filtered into two ranges, an upper and a lower range, which together cover the entire range of fundamental frequencies of the human voice. Since energy in the harmonics of the fundamental frequency often have more energy than the fundamental itself, a range control voltage is generated when there is energy in the lower range which gates off the upper range to exclude the harmonics. If no energy exists in the lower range, the fundamental frequency in the upper range is processed unimpeded. In either case, the output from the filters is amplified in a mixer and is read on a frequency meter which provides a positive DC voltage output proportional to the fundamental frequency at the extractor input. A DC amplifier prepares the pitch signal for input to the computer at a level of 0 to -10 volts.

C. SYSTEM CONSOLE See Figures 5 and 6.

The system console houses several subsystems and is the basic physical unit of the device. Meter displays at the console provide error output information to the experimenter which he, in turn, can channel to the student. Intercommunications are provided at the console for the student and the experimenter. The console provides terminals for the interconnection between the computer and the analog equipment in the system. The console contains an oscilloscope and a graphic recorder for minitoring the signals generated in the system and the alternate error outputs. Any combination of the three error output signals can be monitored at the console by the experimenter.

D. STUDENT BOOTH See Figures 7 and 8.

The student booth is an isolated sound room in which the MODEL

is presented to the student, and in which the student imitates the MODEL by speaking into a microphone. The student panel contains lights which indicate to the student which parameter he is trying to improve, the output meter which indicates his error for the parameter he is trying to improve, and a RESPOND light indicator. The booth is provided with an intercommunication between the experimenter and the student.

E. RELAY CONTROL See Figure 9.

The relay control unit is the heart of the automatic mechanism of the system. It contains one or more relays to perform each of the following functions:

1) Play the tape recorder.
2) Rewind the tape recorder.
3) Stop the tape recorder.
4) Inform the computer when rewind is complete.
5) Interrupt the speakers and extractors during rewind.
6) Direct output of the computer to control or display.
7) Operate RESPOND indicator.
8) Operate parameter indicator.

All the signals which control the operation of these relays are generated either in the computer or by a voice operated relay which operates from the voice signal on the tape recording. The indicator lights in the student booth are paralleled on the system console along with switches to synchronize the indicator control with the computer program.

F. COMPUTER See Figure 10.

The computer is a digital device, the PDP-4 by Digital Equipment Corporation of Maynard, Massachusetts. It has a 4096 word memory, an 18 bit word length, and an 8 microsecond cycle time. It serves as the nerve

center of the system, and performs complex arithmetic manipulations, stores data it has processed, compares new data with that which has been stored, and generates output signals for the purpose of error indication as well as subsystem control. The most critical function of the computer in this system is the time normalization of both MODEL and SUBJECT information so that each SUBJECT parameter value is compared with the corresponding MODEL parameter value stored in memory.

SYSTEM OPERATION

The operation of the SAID system is completely automatic. The only attention it requires is the following procedure to begin operation:

A. Enable the power to the computer with the circuit breakers at the left rear of the computer and the power switch on the computer front panel.

B. Enable the auxiliary clock in the computer with the toggle switch at the right rear of the computer.

C. Read the program, PROJECT SAID, into the computer if it is not already in memory.

D. Depress START on the computer front panel. The computer will start and immediately stop. This clears any output from the computer to the SAID console.

E. Enable the console with the pushbutton power switch above the desktop on the console. A ten minute warming up period should be observed.

F. Synchronize the computer program with the indicator lights by enabling the PITCH light and disabling the RESPOND light. This is accomplished by depressing the RESPOND and P-A-T buttons on the relay control panel.

G. Align the first model to be played on the tape recorder by giving it a two second leader to the playback head.

H. Set the computer address switches and depress START. The tape recorder will begin playing and the automatic system is now in operation.

PROGRAM OPERATION See Figure 11.

The internal operation of the automatic system begins with the START lever on the computer front panel. The tape recorder starts, the program tells the computer it is in the MODEL mode, and the information on the tape is processed into the memory of the computer. When the information on the tape is finished, the voice operated relay stops the tape recorder, the processing stops, and the computer checks its mode. Since the computer was in the MODEL mode, it changes to SUBJECT mode, turns on the respond light, initializes the table of data in memory, prepares the displays for output, and waits for the student to begin his imitation. When the information from the student comes, the processing begins, and continues until the student is finished. At this point the processing stops, and the mode check indicates that the computer has been processing SUBJECT information. The error sum for the parameter being processed is compared to a limit. If it is greater than the limit, the student gets another opportunity to improve his imitation; the respond light goes out, the recorder rewinds, and the process starts over. If the error was less than the limit, the computer goes on to the next parameter, turning on the next parameter light while turning off the RESPOND light, rewinding the recorder, and beginning the process again. If, however, the next parameter is again the first parameter, PITCH, the recorder does not rewind, but plays the next model on the tape recorder.

The output to the experimenter during this process is required for pedagogical and research purposes. When the computer enters the MODEL mode, it types out an "M" on the teleprinter. When it enters the SUBJECT mode, it types out an "S". When it changes parameters, it types out the parameter name which it will be processing. When it compares the error sum of the parameter being processed to its limit, it types out that error sum as well as each error sum and a combination of all the sums.

The outputs to the experimenter are set to display the error of the parameter being processed on channel 0, or the far left meter on the console. The other two meters display the error of the remaining two parameters in the order they are processed: first PITCH, then AMPLITUDE, and finally TEMPO. The model on the tape is considered properly imitated when the student has completed the sequence.

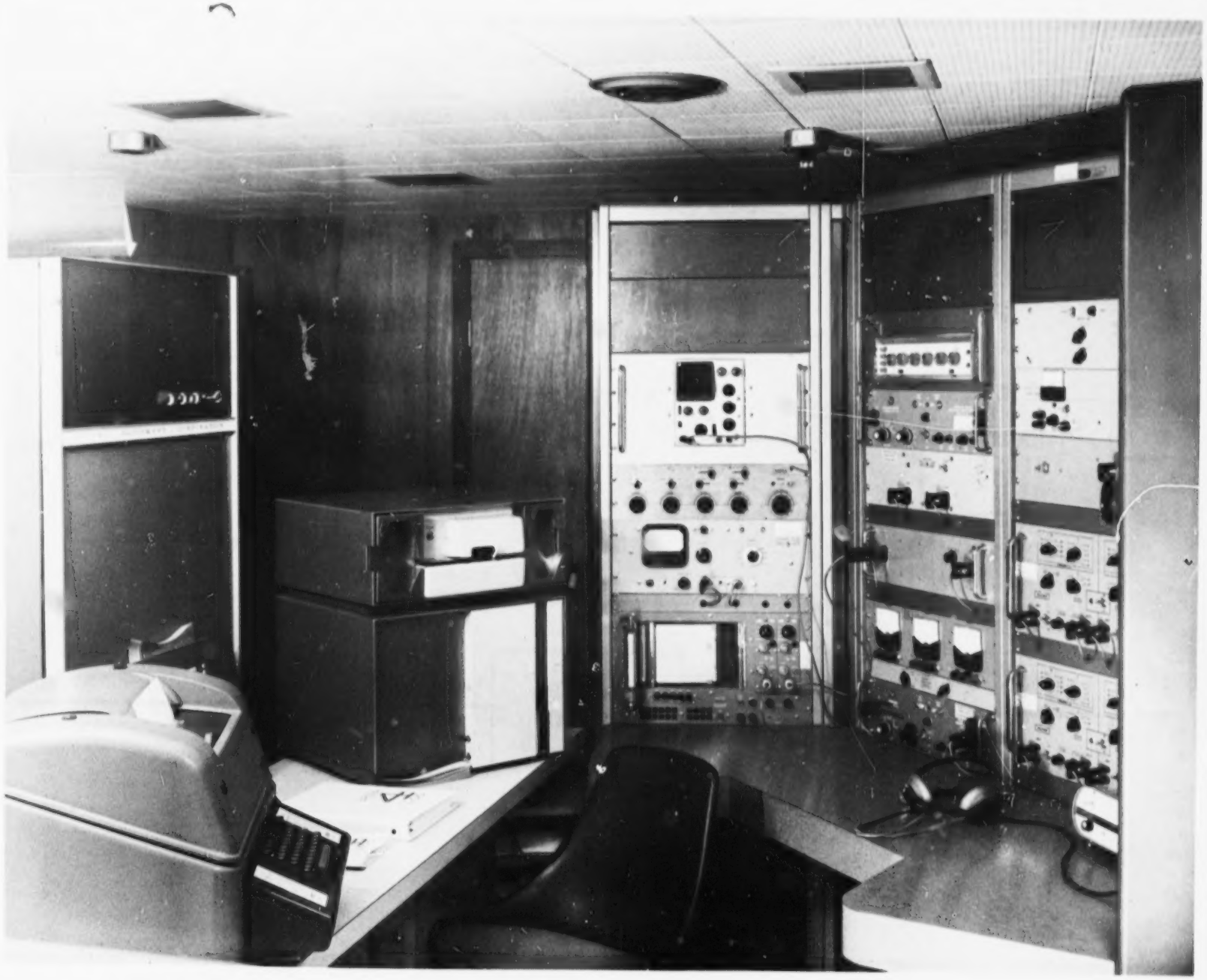
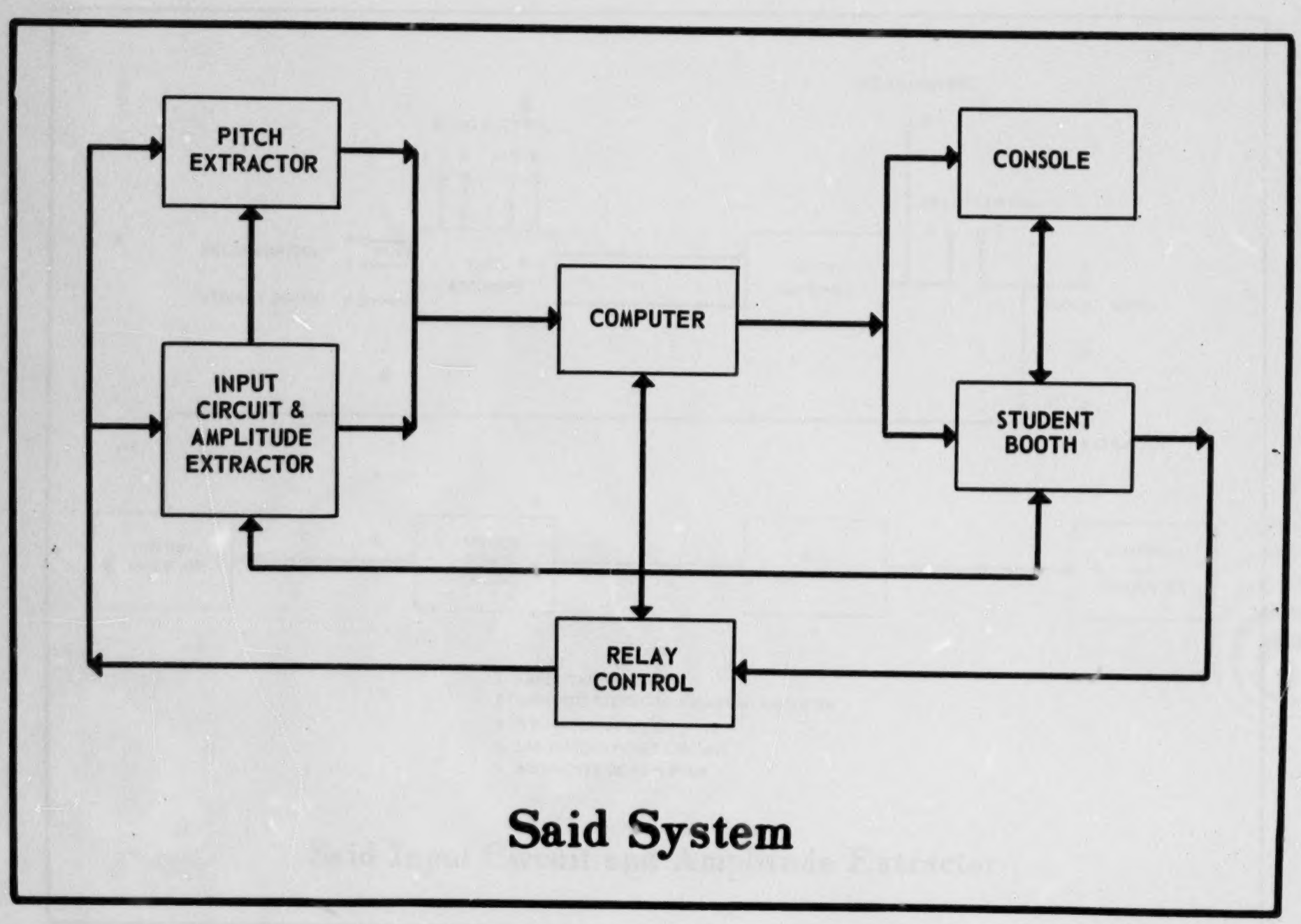
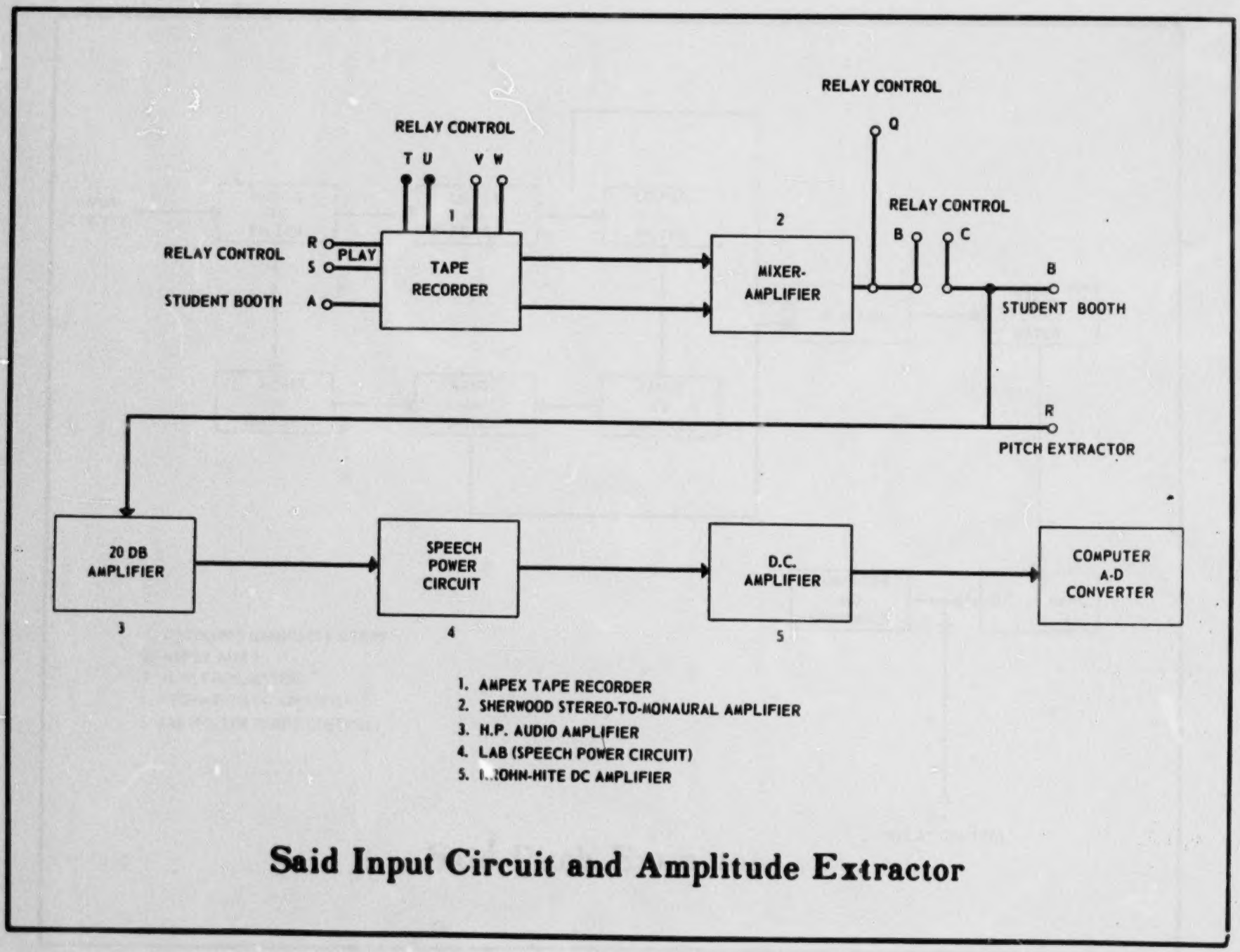


Figure 1



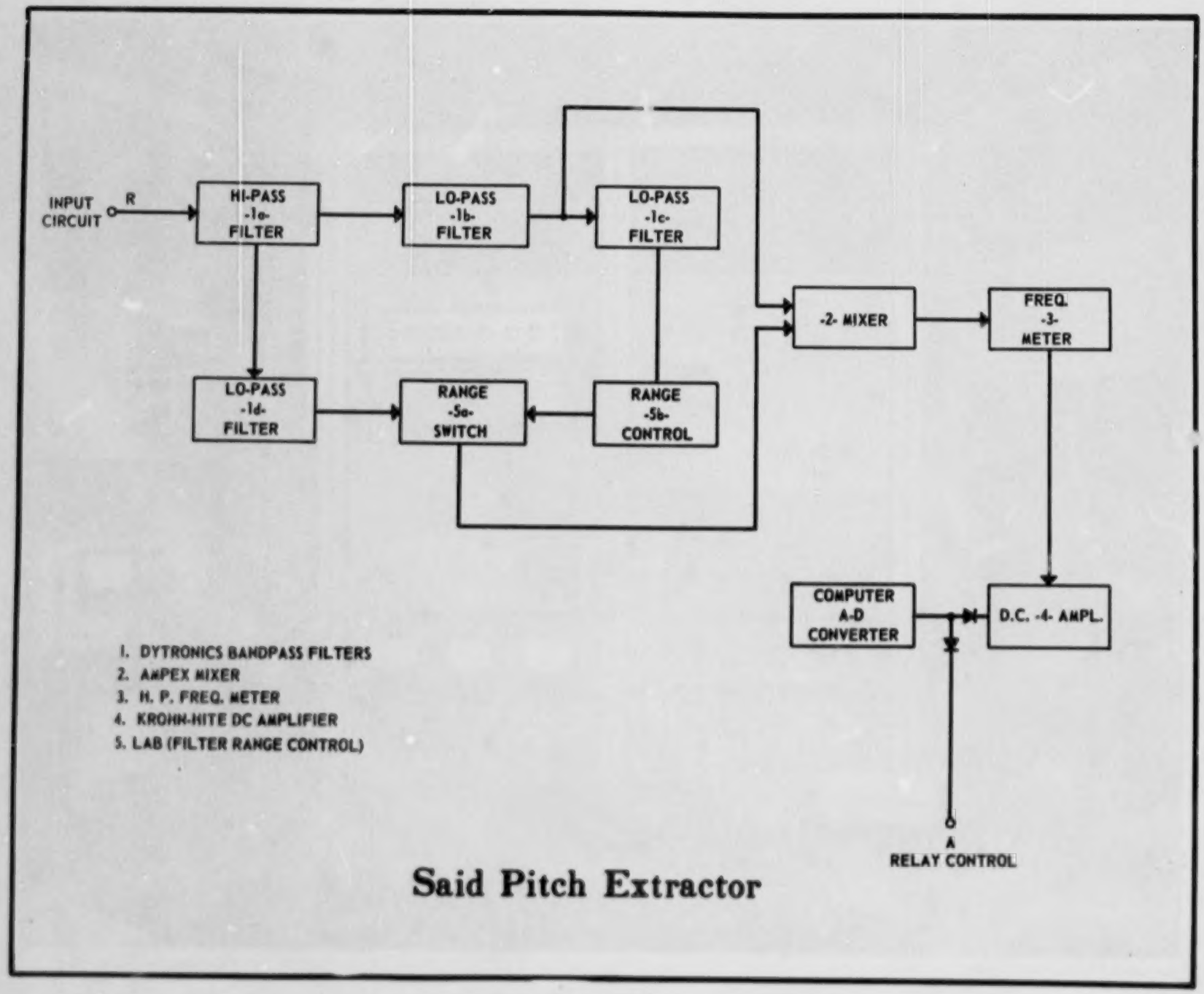
Said System

Figure 2



Said Input Circuit and Amplitude Extractor

Figure 3



Said Pitch Extractor

Figure 4

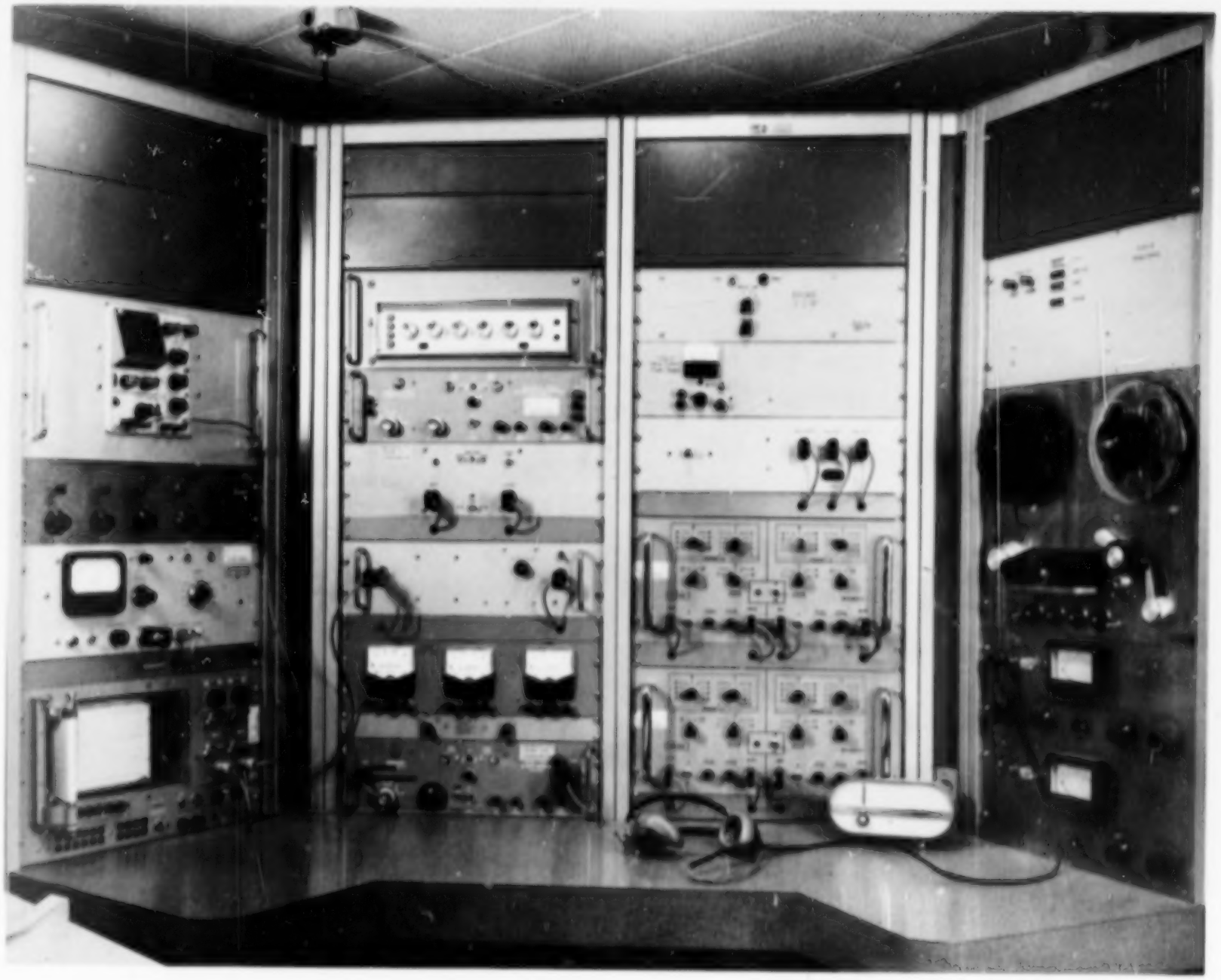


Figure 5

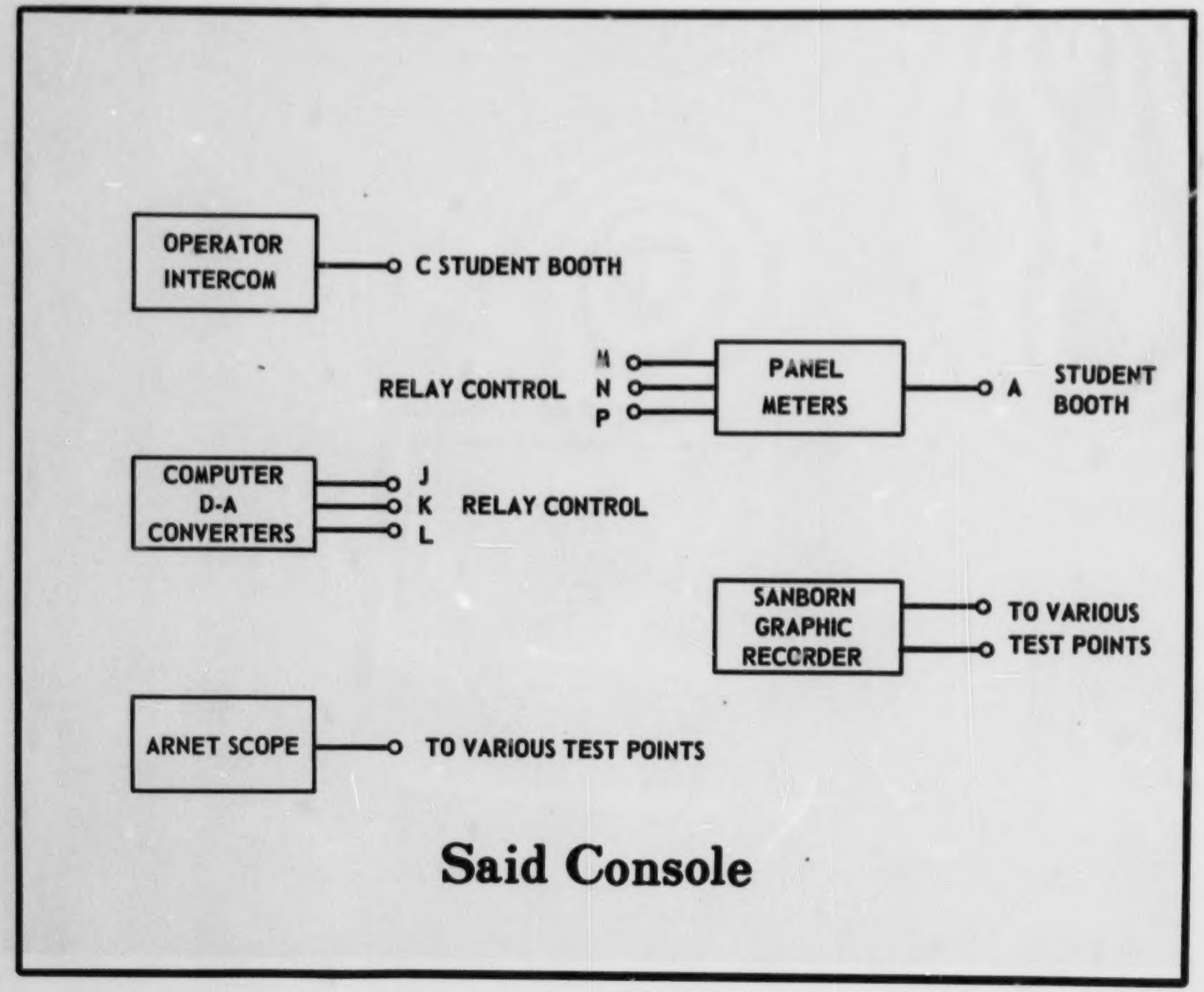

OPERATOR INTERCOM
C STUDENT BOOTH
RELAY CONTROL
M
N
P
PANEL METERS
A
STUDENT BOOTH
COMPUTER D-A CONVERTERS
J
K
L
RELAY CONTROL
SANBORN GRAPHIC RECORDER
TO VARIOUS TEST POINTS
ARNET SCOPE
TO VARIOUS TEST POINTS
Said Console

Figure 6

Figure 7

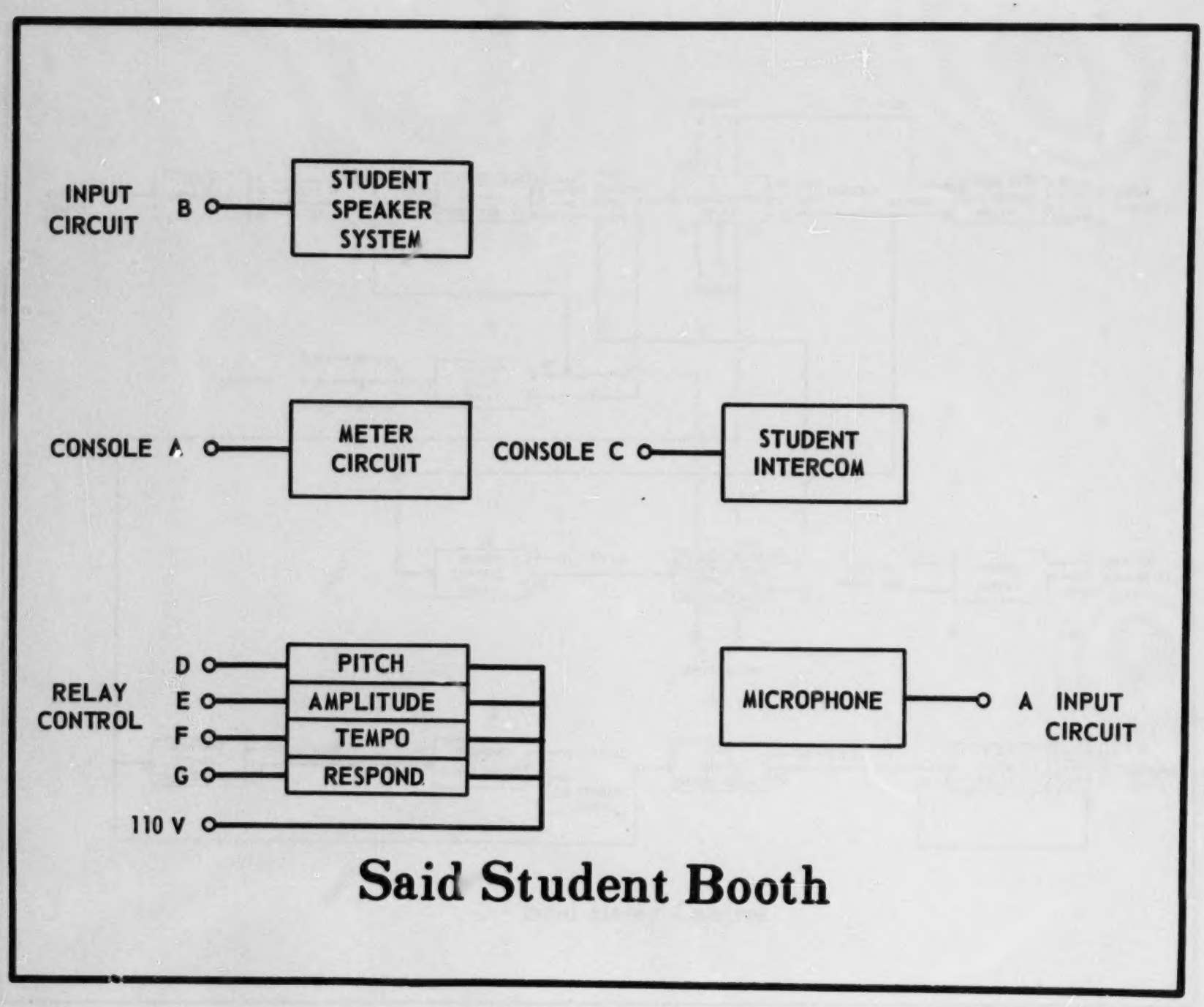
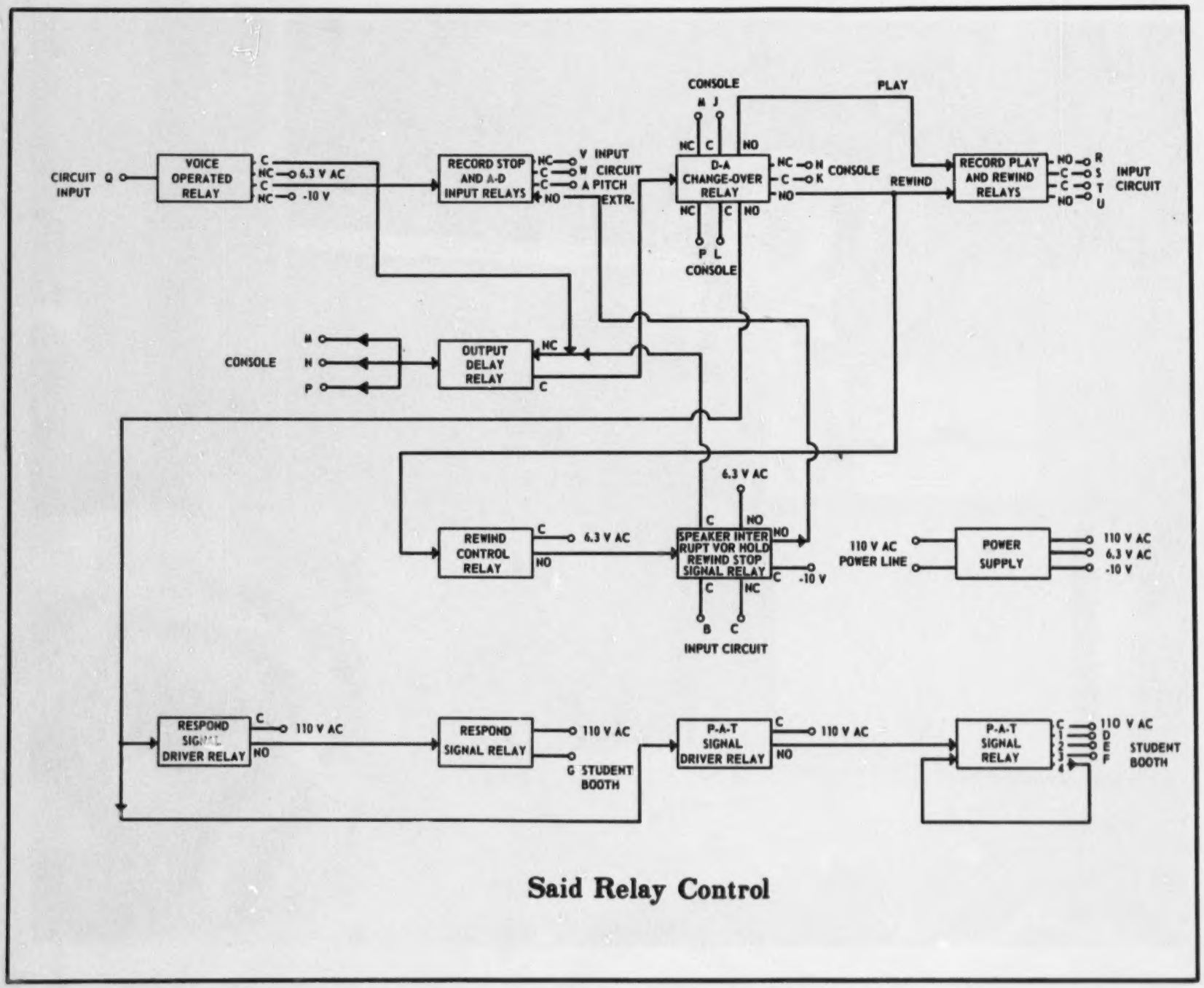

INPUT CIRCUIT
B
STUDENT SPEAKER SYSTEM
CONSOLE A
METER CIRCUIT
CONSOLE C
STUDENT INTERCOM
RELAY CONTROL
D
E
F
G
110 V
PITCH
AMPLITUDE
TEMPO
RESPOND
MICROPHONE
A
INPUT CIRCUIT
Said Student Booth

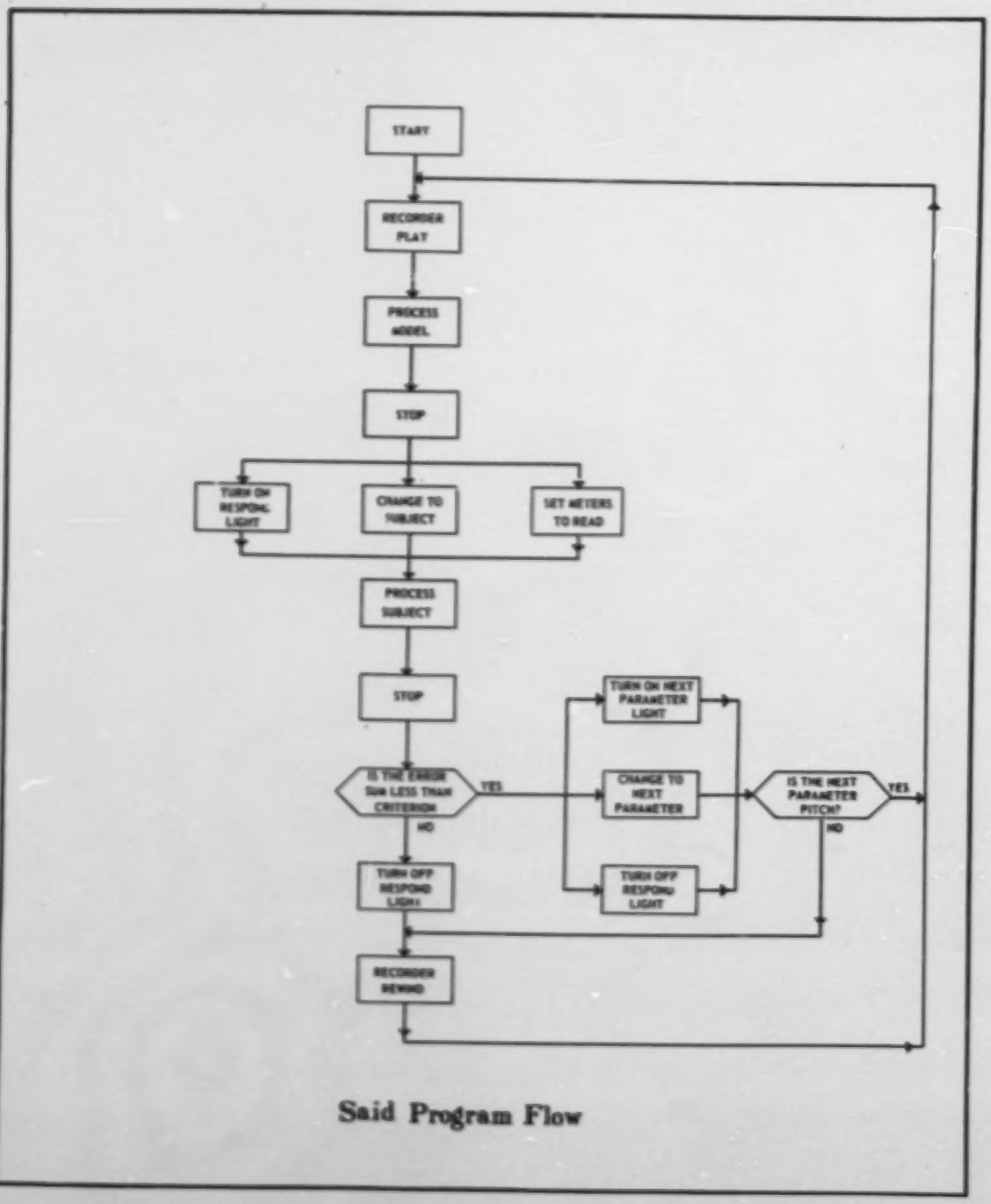
Figure 8



Said Relay Control

Figure 9

Figure 10



Said Program Flow

Figure 11